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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Patrick Vogel and Steffen Lehr
Filed : Herewith
For : METHOD AND ELECTRONIC CIRCUIT FOR CONTROLLING
OF A SUPPLY VOLTAGE OF A LASER DIODE

CLAIM OF PRIORITY UNDER 35 USC 119

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

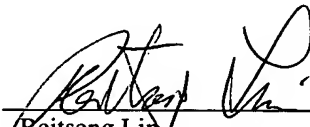
Applicants hereby claim the benefit of priority under 35 USC 119 and under the International Convention for the Protection of Industrial Property of EPO Application No. 03001169.6, filed January 21, 2003.

A certified copy of the priority document is enclosed.

Respectfully submitted,

PATRICK VOGEL ET AL.

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Patentanmeldung Nr. Patent application No. Demande de brevet n°

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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R C van Dijk

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Anmelder/Applicant(s)/Demandeur(s):

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se référer à la description.)

Method and electronic circuit for controlling of a supply voltage of a laser diode

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s)
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Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

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Method and electronic circuit for controlling of a supply
voltage of a laser diode

5

Field of the invention

The present invention generally relates to the field of
controlling of light sources, and more particularly to
controlling of a laser diode of an optical reader and/or
10 recorder, such as CD or DVD players and/or recorders.

Background and prior art

Typically a laser diode is arranged in a PNP type circuit
configuration or, alternatively, in an NPN type circuit
15 configuration. The control of the supply voltage of the
laser diode needs to be adapted to the type of circuit
configuration which is used, otherwise the lifetime of the
laser diode is reduced or the laser diode is even destroyed
when the control of the power supply is initialized.

20 US Patent number 6,363,044 B1 shows a photo diode detection
circuit which is used to automatically identify a type of
photo diode circuit connected to it. Once the type of
photo diode circuit has been identified by applying a
current to it and evaluating a voltage occurring at an
25 input of the detection circuit, the photo detection circuit
adapts itself to it, e.g. a reverse biasing voltage is or
is not applied to the photo diode of the photo diode
circuit. The result is a photo diode detection circuit
which uses a forward or a reversed biased photo diode. The
30 photo diode detection circuit is now in a state to measure
light falling on the photo diode. The detection circuit is
used for monitoring the light intensity of a light source

PD030019*Ku

and for a controlling circuit which enables to regulate the intensity of the light source. It is a disadvantage of this prior art controlling circuit that it does not automatically adapt to the circuit configuration in which
5 the light source is arranged.

Summary of the invention

It is an object of the invention to find a solution for a control circuit and method which automatically adapts to
10 the circuit configuration in which a laser diode is arranged.

A solution to the above described problem is provided by applying the features laid down in the respective independent claims. Preferred embodiments of the invention
15 are given in the dependent claims.

The invention enables an effective protection of a light source, such as a laser diode, against application of a wrong supply voltage. It is a particular advantage of the present invention that this accomplished without a need for
20 an extra control pin and without inputting of control information indicating the kind of circuit configuration of the laser diode. Rather the present invention enables to automatically detect the circuit configuration of the laser diode and to initialize the control of the power supply for
25 the laser diode correspondingly.

The present invention is advantageously employed for optical readers and/or recorders such as CD and/or DVD readers and/or recorders.

Brief description of the drawings

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In the following preferred embodiments of the invention will be described in greater detail by making reference to the drawings in which:

5 Figure 1 shows a block diagram of an embodiment of an electronic circuit of the invention,

Figure 2 shows a detailed view on the module of figure 1 generating the OUTPOL signal,

Figure 3 is an alternative embodiment of the circuit of figure 2,

10 Figure 4 is illustrative of a signal diagram when the output stage is of the PNP type,

Figure 5 is illustrative of a signal diagram when the output stage is of the NPN type,

15 Figure 6 shows an alternative embodiment of the circuit of figure 1 having an additional detector for the polarity of the measurement signal,

Figure 7 to figure 10 are illustrative of signal diagrams of the preferred embodiment of figure 6

20 Detailed description

Figure 1 shows a control circuit 100 having a comparator 102. The comparator 102 has input switches S11, S12, S13 and S14 which determine the output polarity of the comparator 102. The input voltage at pin IN of the
25 comparator 102 is compared with an adjustable reference voltage Vref1.

PD030019*Ku

Further control circuit 100 has an active off circuitry 104, which comprises two current sources Iu Id as well as switches S31 and S32.

A safety block 106 is coupled to the control circuit 100.

5 The safety block 106 decides when the laser control switches from the active off phase into the start up phase. The safety block 106 generates an ENABLE signal when the command ON is applied and if the start up condition (external capacitors are de-charged) are fulfilled.

10 Further there is a safety block 108 which is coupled to the control circuit 100. Safety block 108 serves to determine whether the laser diode which is controlled by the control circuit 100 is in a PNP type or an NPN type circuit configuration. Preferred implementations of safety block
15 108 are illustrated in figures 2 and 3.

A PNP type circuit configuration 110 having a laser diode 112 or alternatively an NPN type circuit configuration 114 comprising laser diode 116 is connected to the output OUT of control circuit 100. The PNP type circuit configuration
20 110 is a driver circuit for the laser diode 112 using an PNP transistor type. Likewise the NPN type circuit configuration 114 is a driver circuit for laser diode 116 using an NPN transistor type.

A measurement photo diode 118 is connected to the input IN
25 of the control circuit 100. The photo diode 118 measures the light emission of the laser diode 112 or laser diode 116, respectively. This way a feedback signal is provided to control circuit 100 which forms the basis for controlling the supply voltage for laser diode 112, or
30 laser diode 116.

PD030019*Ku

The voltage control of the control circuit 100 is adapted by the OUTPOL signal delivered by the safety block 108 depending whether PNP type circuit configuration 110 or NPN type circuit configuration 114 is connected to the output
5 OUT of control circuit 100. In particular the polarity of the comparator 102 and also the active OFF circuitry 104 is adapted accordingly depending on the OUTPOL signal. The operation of the control circuit 100 has several operation modes:

10 - active OFF

The external capacitance of the PNP type circuit configuration 110 or the NPN type circuit configuration 114 is de-charged, so that the laser diode 112 or 116, respectively is OFF. This is a safety requirement in order
15 to avoid destruction of the expensive laser diodes 112 or 116.

- active ON

The laser control is switched off when the start up phase is entered. During the start up phase safety functions are
20 checked and the external capacitors are charged.

- control phase

When all safety checks have been fulfilled the control circuit 100 enters the control phase. The laser diode light emission is regulated based on the reference voltage Vref1.

25 Figure 2 is illustrative of an implementation of the safety block 108. Figure 3 is illustrative of an alternative implementation of the safety block 108 which is preferred to the implementation of figure 2. The INIT block generates a pulse of about 100 nanoseconds pulse length
30 when the supply voltage has reached its nominal value.

PD030019*Ku

With this pulse the OUTPOL signal is set to a default setting. For example the default setting is OUTPOL = 1 which means that the PNP type circuit configuration 110 (cf. figure 1) is the default circuit configuration.

5 Alternatively the NPN type circuit configuration 114 can be chosen as a default configuration.

Figure 4 is illustrative of the initialization of the control of the supply voltage depending on the type of circuit configuration. In the embodiment of figures 4 and 10 5, it is assumed that the default setting is OUTPOL = 1, which means that PNP type circuit configuration 110 is the default circuit configuration..

Figure 4 shows the signal diagram if the circuit configuration of the laser diode is indeed of the PNP type 15 circuit configuration 110.

During the active OFF phase the supply voltage at the output OUT is gradually increased towards the reference voltage V_{refnpn} of the PNP type circuit configuration 110 (cf. Fig. 1). At the same time the measurement signal 20 applied at the input IN is monitored. As the measurement signal applied at the input IN does not show a peak this means that the assumption that the laser diode is in the PNP type circuit configuration 110 is correct and that the polarity of the signal OUTPOL does not need to be changed 25 from the default setting. After the active OFF and the start up phase, the control operation for controlling the supply voltage starts.

Figure 5 shows a corresponding signal diagram when the output circuit configuration is not the default PNP type 30 circuit configuration but an NPN type circuit configuration. Again the supply voltage at the output OUT of the control circuit is gradually increased towards the

PD030019*Ku

reference voltage VREFPNP of the PNP type circuit configuration 110 as the PNP type circuit configuration is the assumed configuration. As the laser diode is in fact arranged in an NPN type circuit configuration application
5 of the gradually increasing supply voltage results in the emission of light from the laser diode and thus in a peak 120 of the measurement signal applied at the input IN.

In response to the peak 120, the polarity of the OUTPOL
10 signal is changed from 1 to 0, and the direction of change of the supply voltage signal at the output OUT is likewise changed into the direction of the voltage reference Vrefnpn of NPN type circuit configuration 114.

Figure 6 shows a block diagram of an extended embodiment
15 based on the embodiment of figure 1. In the embodiment of figure 6 there is photo diode detection circuit 122 between the input IN and the input of control circuit 100. Preferably photo diode detection circuit 122 is designed in accordance with US patent number 6,363,044B1, which is
20 incorporated herein by reference in its entirety.

Due to the photo diode detection circuit 122 it is possible to either use photo diode 118 or reverse biased photo diode 124. In either case the photo diode detection circuit 122 will deliver the same signal INCOMP for inputting into the
25 comparator 102 of the control circuit 100 (cf. figure 1).

As apparent from the signal diagrams of figures 7 to 10, the operation of the control circuit 100 is the same irrespective of whether photo diode 118 or photo diode 124 is used. Figure 7 shows the signal diagram where the laser
30 diode is arranged in the default PNP type circuit configuration and diode 118 is used. Figure 8 shows the

PD030019*Ku

situation where diode 124 is used. In this instance the polarity of the INPOL signal is changed, such that switch S5 of photo diode detection circuit 122 (cf. figure 6) is switched from its '1' to its '0' position.

- 5 Figures 9 and 10 show the corresponding signal diagrams for a laser diode being arrange in an NPN type circuit configuration.

PD030019*Ku

Claims

1. A method for initialising a control of a supply voltage of a light source, such as a laser diode, the light source being arranged in a first circuit configuration having an associated first reference voltage level or the light source being arranged in an alternative second circuit configuration having an associated alternative second reference voltage level, the method comprising the steps of:
- gradually changing the supply voltage into the direction of the first reference voltage,
 - measuring a light emission of the light source while gradually changing the supply voltage,
 - if no light emission is measured: starting the control of the supply voltage of the light source after the first reference voltage has been reached,
 - if a light emission is measured: gradually changing the supply voltage into the direction of the second reference voltage and starting the control of the supply voltage of the light source after the second reference voltage has been reached.
2. The method of claim 1, the first circuit configuration being an NPN type circuit configuration and the second circuit configuration being an NPN type circuit configuration.
3. The method of claim 1 or 2, whereby the light emission of the light source is measured by means of a photodiode.

PD030019*Ku

4. The method of claim 1;2 or 3, further comprising detecting of a polarity of the measurement of the light emission of the laser diode.

5. An electronic circuit for controlling a supply voltage of a light source, such as a laser diode (112, 116), the light source being arranged in a first circuit configuration (110) having an associated first reference voltage level, or the light source being arranged in alternative second circuit configuration (114) having an associated alternative second reference voltage level, the electronic circuit comprising:

- means (100) for gradually changing the supply voltage into the direction of the first reference voltage for initialising the control of the supply voltage,

- means (118; 124) for detecting of a light emission of the laser diode,

- means (100) for gradually changing the supply voltage into the direction of the second reference voltage, if a light emission of the laser diode is detected while the supply voltage is gradually changed into the direction of the first reference voltage.

6. The electronic circuit of claim 5, whereby the first circuit configuration is of an PNP type and the second circuit configuration is of an NPN type.

7. The electronic circuit of claims 5 or 6, the means for detecting a light emission comprising a laser diode.

8. The electronic circuit of claims 5, 6 or 7, further comprising means (122) for detecting of a polarity of a

PD030019*Ku

measurement signal provided by the means for detecting
of a light emission.

- 5 9. An optical reader and/or recorder comprising a laser
diode and an electronic circuit for controlling of a
supply voltage of the laser diode in accordance with
any one of the proceeding claims 5 to 8.

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Abstract

Method and electronic circuit for controlling of a supply voltage of a laser diode

- 5 The invention relates to a method for initialising a control of a supply voltage of a light source, such as a laser diode, the light source being arranged in a first circuit configuration having an associated first reference voltage level or the light source being arranged in an
- 10 alternative second circuit configuration having an associated alternative second reference voltage level, the method comprising the steps of:
- gradually changing the supply voltage into the direction of the first reference voltage,
 - 15 - measuring a light emission of the light source while gradually changing the supply voltage,
 - if no light emission is measured: starting the control of the supply voltage of the light source after the first reference voltage has been reached,
 - 20 - if a light emission is measured: gradually changing the supply voltage into the direction of the second reference voltage and starting the control of the supply voltage of the light source after the second reference voltage has been reached.

25 (Figure 1)

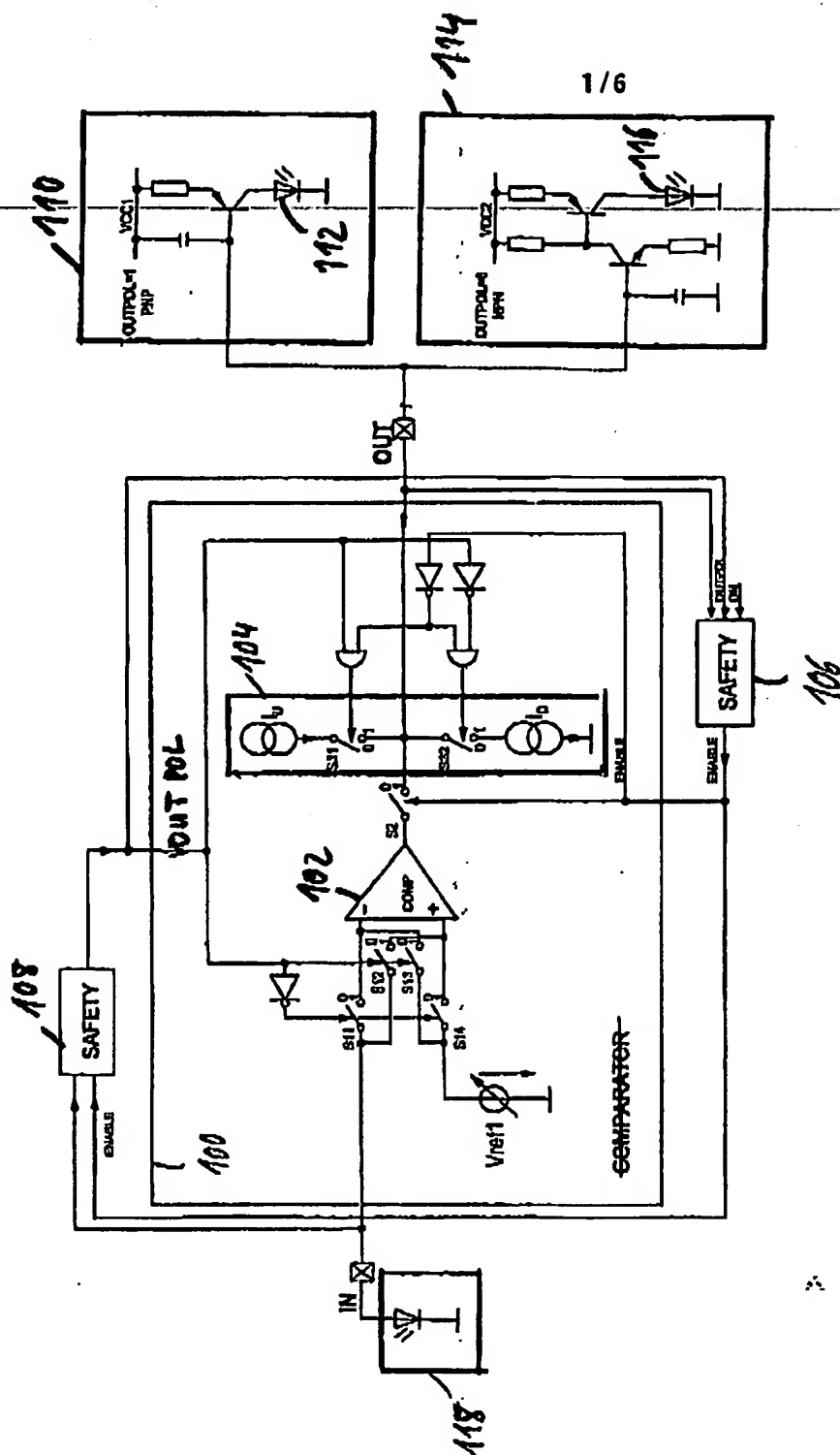
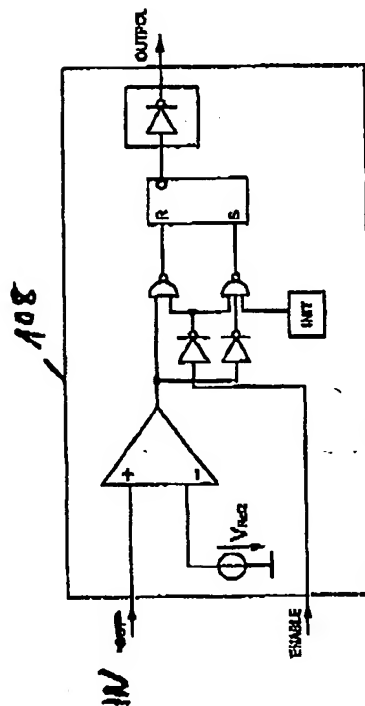
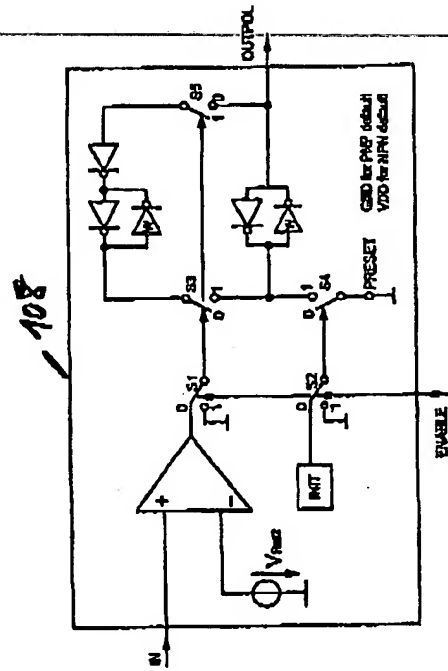


Fig. 1

2/6

DETAIL OUTPUT



PD030019

3/6

default setting $OUTPOL=1$ (PNP)

1) output stage is PNP



Fig. 4

2) output stage is NPN

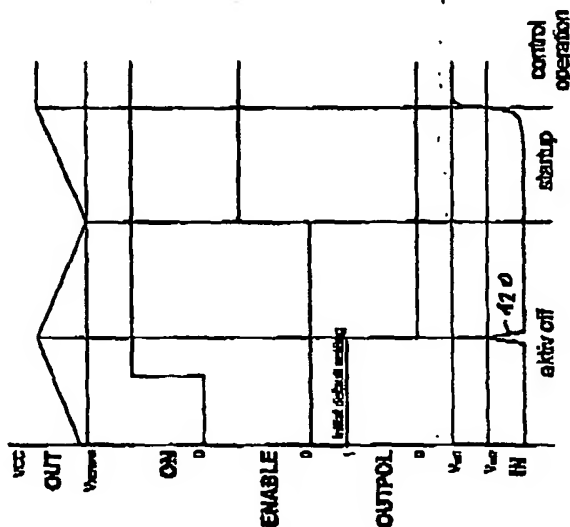


Fig. 5

4/6

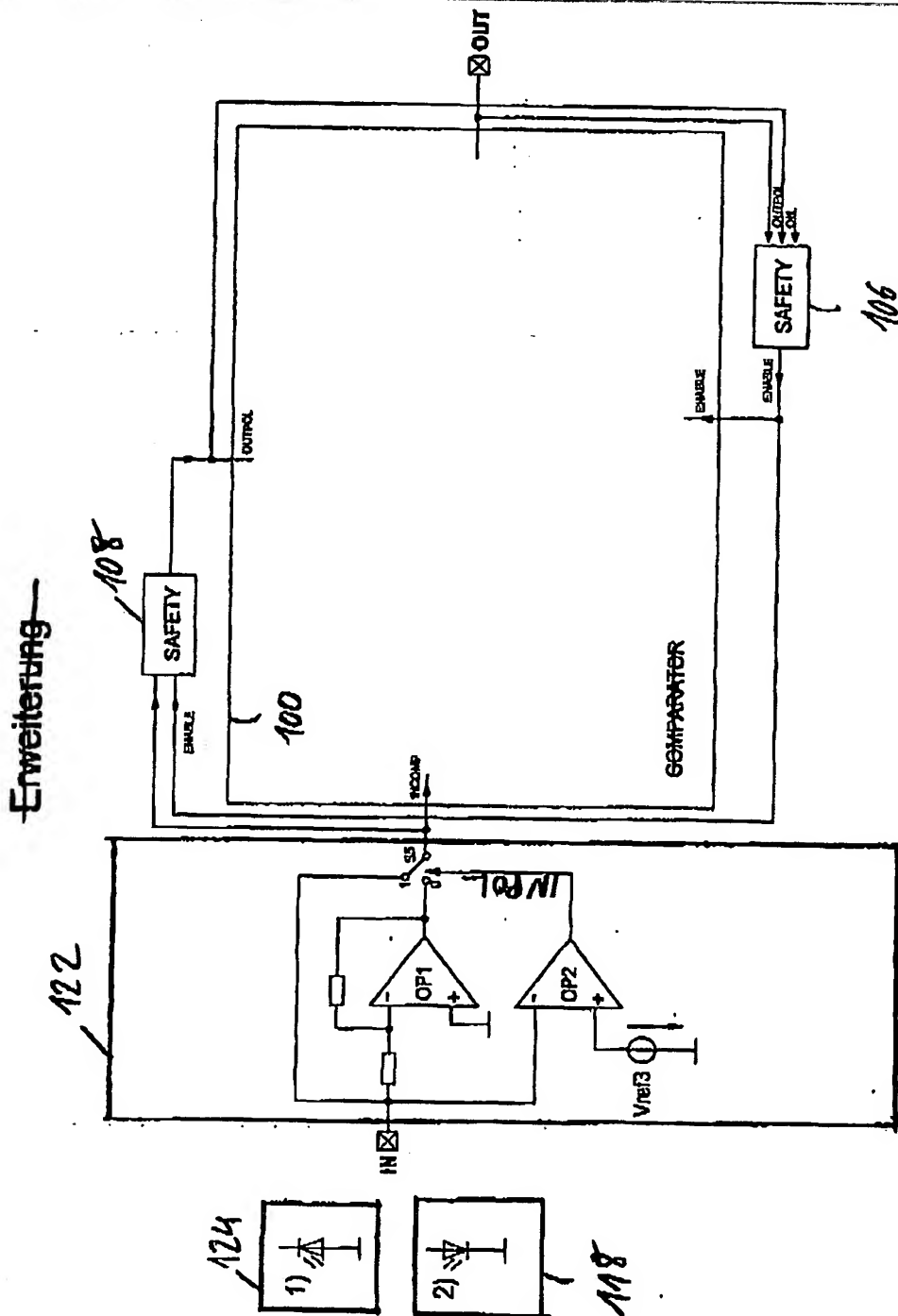


Fig. 6

5/6

~~Erweiterung 1)~~
default setting OUTPUT=1 (PNP)

3) PNP outputstage pos. IN polarity

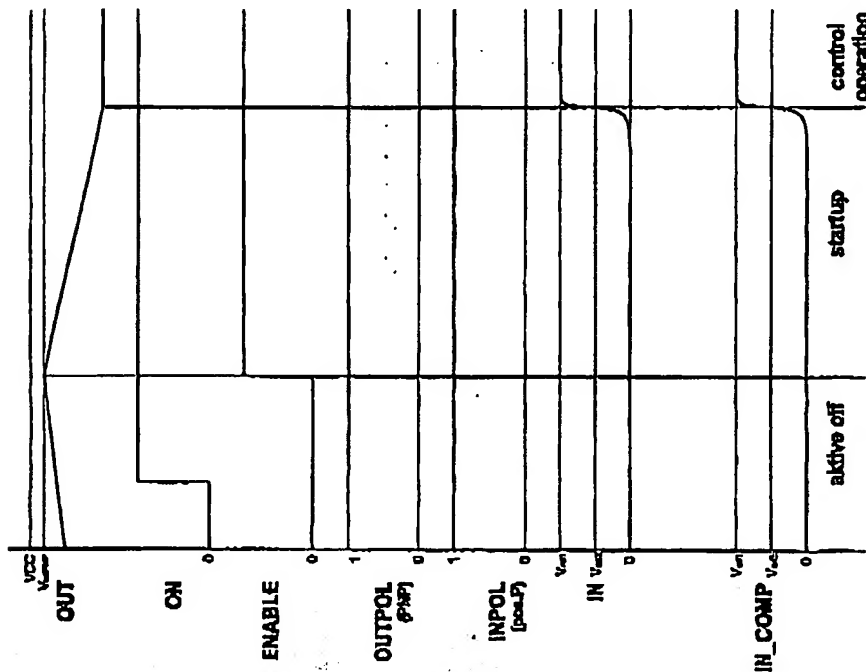


Fig. 7

4) PNP outputstage neg. IN polarity

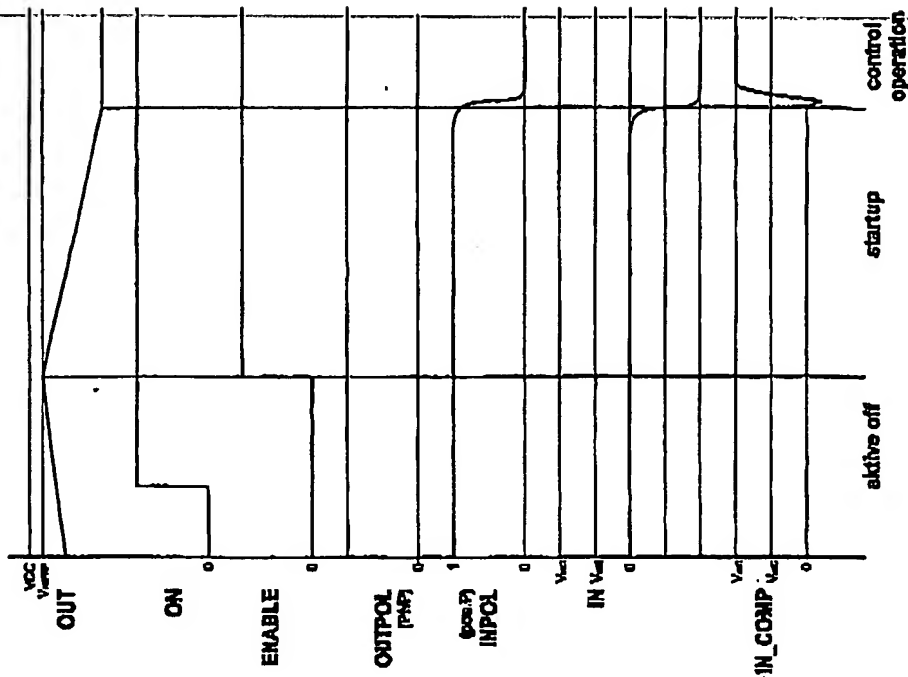


Fig. 8

6/6

Erweiterung 2)
default setting OUTPUT=1 (PNP)

3) NPN outputstage pos. IN polarity

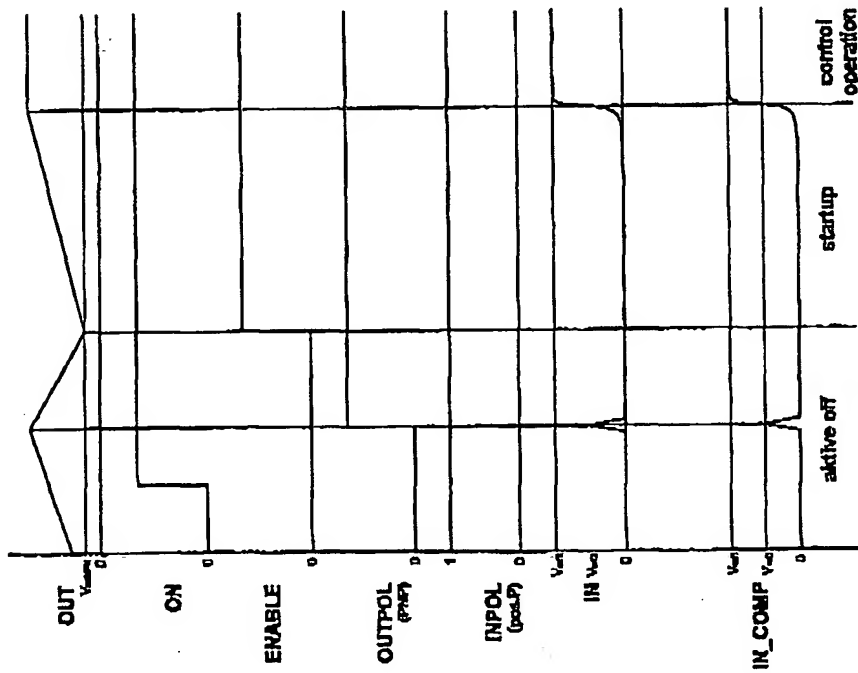


Fig. 9

4) NPN outputstage neg. IN polarity

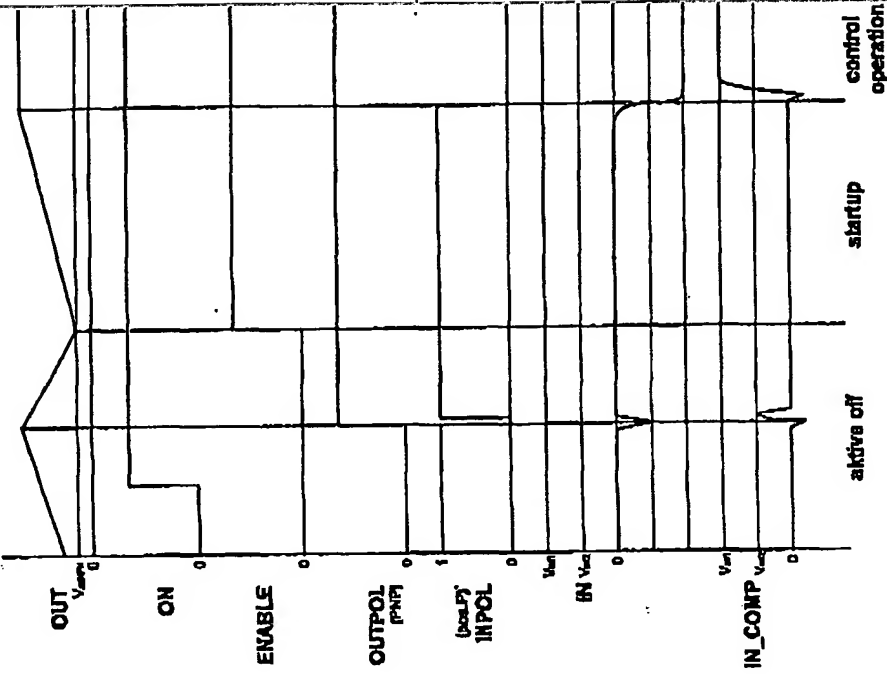


Fig. 10